REMARKS

Claims 9-15, 36-57, 61-62, and 66-69 remain in the application. Claims 1-8, 16-35, 58-60 and 63-65 were previously cancelled with the preliminary amendment filed December 14, 2001. Claims 9-10, 15, 36, 42, 47-48, 54-55, 66 and 68-69 are hereby amended. No new matter has been added.

35 USC 103 (a)

I. Reinhorn in view of Todokoro (Claims 9-15, 36-40, 43-51, and 57)

Claims 9-15, 36-40, 43-51, and 57 were rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 6,317,514 to Reinhorn, in view of U.S. Patent No. 6,310,341 to Todokoro. Applicants respectfully traverse this rejection.

Reinhorn is directed to a system that scans a deep UV beam spot across a patterned wafer surface. The apparatus of Reinhorn determines the integrity of high aspect ratio (HAR) structures (contact holes and vias) on the patterned wafer. (See Abstract of Reinhorn.) Reinhorn teaches the use of a small and intense beam spot of light and scanning that spot across the surface to be inspected. (See column 5, lines 1-10 of Reinhorn.) Reinhorn further teaches a perpendicular (90 degree) incident angle of the light beam onto the substrate surface. (See Figs. 2 and 3 in Reinhorn.) The perpendicular incident angle in Reinhorn enables the integrity of HAR structures to be examined.

Todokoro is directed to a system utilizing an incident electron beam. An image is formed in Todokoro by way of a projection-type electron lens configuration. (See Abstract of Todokoro.)

Independent claim 9 is hereby amended in relation to the antecedent basis of the words "surface" and "plane" and to more distinctly claim applicants' invention. Claim 9 as amended recites the following limitations.

a) exposing a multi-pixel area of said wafer or said reticle to an influx of photons selected to cause photoelectrons to leave surface of said wafer or said reticle,
b) focusing said photoelectrons to create an image of said area of said wafer or said reticle in a plane of the detector, and
c) detecting said photoelectrons, thereby imaging said area of said wafer or said reticle.

(Emphasis added.)

As recited above, claim 9 relates to "exposing a multi-pixel area of said wafer or said reticle to an influx of photons" and "focusing said photoelectrons to create an image of said area of said wafer or said reticle in a plane of the detector." The multi-pixel exposure and focusing in the detector plane as claimed is patentably distinct and advantageous over methods that use raster scanning and that do not focus the photoelectrons to create an image at the detector plane.

In contrast to the claimed invention, Reinhorn scans a focused light beam spot (single pixel) across the wafer. "Element 22 is short wavelength light source and 23 indicates a scanner for shifting the light beam 24 to scan the wafer strip-wise. The light beam 24 is focused by objective 25 to form a spot on the wafer surface." (Reinhorn, col. 5, lines 27-30, emphasis added.) Furthermore, Reinhorn does not disclose or suggest focusing the photoelectrons such that an image is created in the plane of the detector. The raster scanning of Reinhorn is disadvantageously slow and so results in limited inspection throughput.

Todokoro is generally directed to the use of incident electrons (rather than to using photons as claimed). The use of incident electrons in Todokoro is disadvantageous in that it results in higher chromatic aberration and hence lower resolution. Although Todokoro does disclose certain electron imaging components, the straightforward substitution of the electron imaging components of Todokoro into the apparatus of Reinhorn would not be operable and hence have no reasonable expectation of success. For example, the scanner 23 of Reinhorn and the imager 210 of Todokoro are both configured perpendicularly to the wafer and so would interfere with each other; either the incident light from the scanner 23 of Reinhorn or the photoelectrons going to the imager 210 of Todokoro would be blocked. (See FIG. 2 of Todokoro and FIG. 2 of Reinhorn.)

Hence, neither Reinhorn, nor Todokoro, nor the combination thereof, discloses or suggests the claimed "exposing a multi-pixel area of said wafer or said reticle to an influx of photons" and "focusing said photoelectrons to create an image of said wafer or said reticle in a plane of the detector." Therefore, applicants respectfully submit that the method of claim 9 as amended is now patentably distinct over the combination of Reinhorn and Todokoro.

Claim 10 depends from claim 9 and has been amended. Furthermore, claim 10 as amended now requires "processing the image to detect and classify defects." (Emphasis added.) Applicants respectfully submit that the defect detection in Reinhorn is based on material classification, not defect classification. (See column 3, lines 50-54 of Reinhorn.) In particular, Reinhorn discloses the detection of a defect in terms of whether a contact hole or via is blocked or clear. However, Reinhorn does not appear to disclose finding multiple defects of various types and then further processing to classify the multiple defects (into the defect types).

Claims 11 and 12 depend from claim 10. Claims 11 and 12 are patentable over the combination of Reinhorn and Todokoro for at least the reasons discussed above in relation to claims 9 and 10.

Claim 13 also depends from claim 10. Furthermore, claim 13 requires that the influx of photons be oriented at an angle of less than 90 degrees to the surface such that sensitivity to topographical defects is increased. There appears to be no disclosure in Reinhorn or Todokoro of such angling of a photon influx to increase sensitivity to topological defects.

Claim 14 also depends from claim 10. Claim 14 is patentable over the combination of Reinhorn and Todokoro for at least the reasons discussed above in relation to claim 10. Furthermore, claim 14 requires the influx of photons to be vertically polarized. The specified vertically polarized light is distinct over and above spatially coherent laser light. In particular, when incident at a low angle with respect to the surface of the substrate, the vertically polarized light makes the surface appear bright in the resultant image. (See pages 9-10 in the specification of the present application.) There appears to be no disclosure in Reinhorn or Todokoro relating to such vertical polarization of the incident photon flux.

Claim 15 is hereby amended solely to add a comma for purposes of consistency and not in relation to overcoming prior art. Claim 15 also depends from claim 10. Claim 15 is patentable over the combination of Reinhorn and Todokoro for at least the reasons discussed above in relation to claim 10. Furthermore, claim 15 requires the influx of photons to be horizontally polarized. Advantageously, when incident at a low angle with respect to the surface of the substrate, the horizontally polarized light makes the planar surface relatively darker than features that rise above or dip below the planar surface. This results in a high

degree of image contrast for particle defects, which appear bright against a dark background. (See pages 9-10 in the specification of the present application.) There appears to be no disclosure in Reinhorn and Todokoro relating to such horizontal polarization of the incident photon flux.

Independent claim 36 is hereby amended in regards to the antecedent basis of "plane" and to more distinctly claim the applicants' invention. Claim 36 as amended now recites the following limitations.

a) exposing an area of said substrate to an influx of photons, said photons having an energy selected to cause photoelectrons to leave said substrate,
b) exposing said area of said substrate to an influx of electrons, said electrons having both an energy and a current density profile selected to maintain surface charge present on said substrate at a predetermined level,
c) focusing said photoelectrons to create an image of said area of said substrate in a plane of a detector, and
d) detecting said photoelectrons, thereby imaging said area of said substrate.

(Emphasis added.)

Similar to claim 9, claim 36 now recites "exposing an area of said substrate to an influx of photons" and "focusing said photoelectrons to create an image of said area of said substrate in a plane of the detector." In addition, claim 36 further distinguishes over the combination of Reinhorn and Todokoro by "exposing said area of said substrate to an influx of electrons, said electrons having both an energy and a current density profile selected to maintain surface charge present on said substrate at a predetermined level." Reinhorn briefly mentions an electron gun, but Reinhorn relates to a spot scanning system where maintaining surface charge would be problematic due to the highly concentrated nature of the electron loss near the spot. In contrast, the claimed invention exposes a multi-pixel area and so has more evenly distributed electron loss that is more effectively compensated using such an exposure to electrons.

Claim 37 depends from claim 36. Claim 37 is patentable over the combination of Reinhorn and Todokoro for at least the reasons discussed above in relation to claim 36.

Claim 38 also depends from claim 36. Furthermore, claim 38 further requires concurrently exposing the substrate to the influx of photons and the influx of electrons. This is contrary to the teaching of Reinhorn where the electron gun "direct[s] electrons to areas that are already scanned" (column 6, line 47 of Reinhorn). In other words, the electron gun in Reinhorn is used after the light beam, not concurrently with it. Advantageously, the concurrent exposure may more effectively control charging.

Claim 39 also depends from claim 36. Furthermore, claim 39 further requires alternating the exposure to the influx of photons and the influx of electrons. This is contrary to the teaching of Reinhorn where the electron gun is used only after the light beam, not in an alternating fashion. Advantageously, the alternating exposure may more effectively control charging.

Claim 40 also depends from claim 36. Furthermore, claim 40 further requires exposing a first area to the influx of photons and a second area to the influx of electrons, were the first area is substantially contained within the second area. In other words, the area exposed to the influx of electrons is larger than but includes the area exposed to the influx of photons. This may also advantageously lead to more effective charge control.

Claim 43 and 44 depend from claim 36. Claims 43 and 44 are patentable over the combination of Reinhorn and Todokoro for at least the reasons discussed above in relation to claim 36.

Claim 45 also depends from claim 36. Furthermore, claim 45 as amended now requires that the influx of photons be oriented at an angle of less than 90 degrees to the surface such that sensitivity to topographical defects is increased. There appears to be no disclosure in Reinhorn or Todokoro of such angling of a photon influx to increase sensitivity to topological defects.

Claim 46 also depends from claim 36. Furthermore, claim 46 requires the influx of photons to be vertically polarized. The specified vertically polarized light is distinct over and above spatially coherent laser light. In particular, when incident at a low angle with respect to the surface of the substrate, the vertically polarized light makes the surface appear bright in the resultant image. (See pages 9-10 in the specification of the present application.) There

appears to be no disclosure in Reinhorn or Todokoro relating to such vertical polarization of the incident photon flux.

Claim 47 is hereby amended solely to add a comma for purposes of consistency and not in relation to overcoming prior art. Claim 47 also depends from claim 36. Furthermore, claim 47 requires the influx of photons to be horizontally polarized. Advantageously, when incident at a low angle with respect to the surface of the substrate, the horizontally polarized light makes the planar surface relatively darker than features that rise above or dip below the planar surface. This results in a high degree of image contrast for particle defects, which appear bright against a dark background. (See pages 9-10 in the specification of the present application.) There appears to be no disclosure in Reinhorn or Todokoro relating to such horizontal polarization of the incident photon flux.

Independent claim 48 is hereby amended in regards to the antecedent basis of "plane". Claim 48 now recites the following limitations.

a) exposing said substrate to an influx of photons, said photons having an energy selected to cause photoelectrons to leave said substrate,
b) exposing said substrate to an influx of electrons, said electrons having both an energy and a current density profile selected to maintain surface charge present on said substrate at a predetermined level,
c) focusing the portion of said influx of electrons which are reflected from said substrate to create an image of said substrate in a plane of a detector, and
d) detecting the portion of said influx of electrons which are reflected from said substrate, thereby imaging a portion of said substrate.

(Emphasis added.)

Like claim 36, claim 48 relates to exposing a substrate to both an influx of photons and an influx of electrons. Unlike claim 36, claim 48 relates to a method where the reflected electrons (rather than the photoelectrons) are imaged. Applicants respectfully submit that the method of claim 48 is patentably distinct over the combination of Reinhorn, Todokoro, and Ose.

Claim 49 depends from claim 48. Claim 49 further requires concurrently exposing the substrate to the influx of photons and the influx of electrons. This is contrary to the

teaching of Reinhorn where the electron gun "direct[s] electrons to areas that are already scanned" (column 6, line 47 of Reinhorn). In other words, the electron gun in Reinhorn is used after the light beam, not concurrently with it. Advantageously, the concurrent exposure may more effectively control charging.

Claim 50 also depends from claim 48. Furthermore, claim 50 further requires alternating the exposure to the influx of photons and the influx of electrons. This is contrary to the teaching of Reinhorn where the electron gun is used only after the light beam, not in an alternating fashion. Advantageously, the alternating exposure may more effectively control charging.

Claim 51 also depends from claim 48. Furthermore, claim 51 further requires exposing a first area to the influx of photons and a second area to the influx of electrons, were the first area is substantially contained within the second area. In other words, the area exposed to the influx of electrons is larger than but includes the area exposed to the influx of photons. This may also advantageously lead to more effective charge control.

Independent claim 57 recites the following limitations.

a) exposing said defect to an influx of photons, said photons having an energy below the energy required to cause photoelectrons to leave said defect,
b) increasing the energy of said photons in discrete steps,
c) monitoring the photoelectron yield from said defect after each step, and
d) identifying the chemical composition of said defect on the basis of the photon energy at which said photoelectron yield increases substantially.

(Emphasis added.)

Applicants respectfully submit that the limitations b), c), and d) do not appear to be disclosed or suggested in Reinhorn, or Todokoro, or the combination thereof. In regards to Reinhorn, the selection of a single photon energy is taught. This teaching of Reinhorn is contrary to limitation b) where the photon energy is incremented in discrete steps.

II. Reinhorn in view of Todokoro in view of Ose (Claims 41-42, 52-56, 61-62, and 66-69)

Claims 41-42, 52-56, 61-62, and 66-69 were rejected under 35 U.S.C. 103(a) as being unpatentable over Reinhorn, in view of Todokoro, in further view of U.S. Publication No. 2001/0010357 to Ose. Applicants respectfully traverse this rejection.

Ose is directed to a scanning electron microscope (SEM) with an image shifting deflector system. Ose recites, "It is possible to prevent the secondary electrons from passing the central aperture of the conversion electrode 16 by disposing an energy filter 60 including a plurality of layers of meshes below the conversion electrode 16. . . ." (Ose, paragraph 31.) Hence, according to Ose, the energy filter 60 may be used to prevent some of the secondary electrons from traveling back up the central aperture in the conversion electrode 16 (and thereby bypassing the conversion electrode 16 and avoiding detection).

Claim 41 depends from claim 36. Claim 41 further requires filtering such that the photoelectrons (or a portion thereof) are selected while most or all of the reflected electrons are rejected. Thus, claim 41 uses filtering to differentiate between photoelectrons caused by the influx of photons and reflected electrons caused by the influx of electrons. Here, the claimed filtering is used to advantageously isolate detection of photoelectrons (while avoiding detection of reflected electrons).

In contrast, Ose discloses an energy filter 60 that is merely used to prevent some of the secondary electrons from passing through a hole in the conversion electrode 16. In other words, Ose discloses using an energy filter 60 to ensure that a greater amount of secondary electrons are detected. This use of an energy filter 60 is very different from the filtering in accordance with claim 41 discussed above.

Claim 42 is hereby amended for purposes of clarification only (to correct a typographical error in the claim dependency) and has not been amended for purposes of overcoming prior art. Claim 42 as amended now depends from claim 41. Claim 42 further requires the electron filtering to be achieved by selection based on angular distribution. In regards to Ose, the angular filter 62 in Ose does not select photoelectrons while rejecting reflected electrons.

Claim 52 depends from claim 48. Furthermore, claim 52 requires electron filtering such that the reflected electrons (or a portion thereof) is selected while most or all of the

photoelectrons are rejected. Here, the claimed filtering advantageously isolates detection of the reflected electrons (while avoiding detecting the photoelectrons). In contrast, as discussed above in relation to claim 41, Ose discloses using an energy filter 60 to ensure that a greater amount of secondary electrons are detected.

Claim 53 depends from claim 52. Claim 53 further requires the electron filtering to be achieved by selection based on angular distribution from the surface of the substrate. In regards to Ose, the angular filter **62** in Ose does not select photoelectrons while rejecting reflected electrons.

Claim 54 is hereby amended to insert a comma and to correct the antecedent basis of "specular angle" and has not been amended for purposes of overcoming prior art. Claim 54 depends from claim 53. Furthermore, claim 54 requires said filtering to reject most or all reflected electrons which are reflected at or near a specular angle and to select most or all reflected electrons which are scattered away from the specular angle. Ose does not disclose or suggest such filtering that rejects electrons reflected around a specular angle.

Independent claim 55 is hereby amended in regards to the antecedent basis of "plane". Claim 55 now recites the following limitations.

a) exposing said substrate to an influx of photons, said photons having an energy selected to cause photoelectrons to leave said substrate,
b) exposing said substrate to an influx of electrons, said electrons having both an energy and a current density profile selected to maintain surface charge present on said substrate at a predetermined level,
c) focusing the portion of said influx of electrons which are reflected from said substrate to create an image of said substrate in the plane of a detector,
d) focusing said photoelectrons in a plane of a detector, and
e) detecting said photoelectrons and reflected electrons, thereby imaging a portion of said substrate.

(Emphasis added.)

Like claim 36, claim 55 relates to exposing a substrate to both an influx of photons and an influx of electrons. Beyond claim 36, claim 55 relates to a method where both the reflected

electrons and the photoelectrons are imaged. Applicants respectfully submit that the method of claim 55 is patentably distinct over Reinhorn, Todokoro, or Ose, or the combination thereof. In particular, Ose does not disclose or suggest such imaging of both reflected electrons and photoelectrons.

Claim 56 depends from claim 55. Furthermore, claim 56 requires filtering to reject most or all of the reflected electrons at or near the specular angle and to reject most or all of the perpendicularly emitted photoelectrons. Neither Reinhorn, nor Todokoro, nor Ose disclose or suggest such filtering.

Independent claim 61 is hereby amended in regards to the antecedent basis of "plane". Claim 61 now recites the following limitations.

a) exposing said substrate to an influx of relatively high-energy electrons, said high-energy electrons having an energy selected to cause secondary electrons to leave said substrate,

b) exposing said substrate to an influx of relatively low-energy electrons, said electrons having both an energy and a current density profile selected to maintain surface charge present on said substrate at a predetermined level,

c) filtering the flux of said secondary electrons and said low-energy electrons reflected from the surface of said substrate in order to select most or all of said secondary electrons, or a portion of said secondary electrons, and to reject most or all of said reflected electrons,

d) focusing said secondary electrons to create an image of said substrate in a plane of a detector, and

e) detecting said secondary electrons, thereby imaging a portion of said substrate.

(Emphasis added.)

Claim 61 requires both a) exposing said substrate to an influx of relatively high-energy electrons to cause emission of secondary electrons and b) exposing said substrate to an influx of relatively low-energy electrons to maintain surface charge. In addition, claim 61 requires c) filtering is applied to select the secondary electrons while rejecting the reflected low-energy electrons, and d) focusing said secondary electrons to create an image of said

substrate in the plane of a detector. In other words, claim 61 isolates detection of the secondary electrons (while avoiding detection of the reflected electrons).

Regarding Ose, the acceleration or deceleration capability in the electron gun of Ose relates to varying the energy of a relatively high-energy electron beam; it does not provide an influx of relatively low-energy electrons for surface charge maintenance as recited in limitation b). Moreover, Ose does not disclose or suggest c) filtering to select the secondary electrons while rejecting the reflected low-energy electrons. Hence, applicants respectfully submit that the method of claim 61 is patentable over the combination of Reinhorn, Todokoro, and Ose.

Claim 62 depends from claim 61. Furthermore, claim 62 requires the electron filtering to be achieved by selection based on angular distribution from the surface of the substrate. In regards to Ose, the angular filter labeled **62** in Ose does not select photoelectrons while rejecting reflected electrons.

Independent claim 66 is hereby amended in regards to the antecedent basis of "plane". Claim 66 now recites the following limitations.

a) exposing said substrate to an influx of relatively high-energy electrons, said high-energy electrons having an energy selected to cause secondary electrons to leave said substrate,

b) exposing said substrate to an influx of relatively low-energy electrons, said electrons having both an energy and a current density profile selected to maintain surface charge present on said substrate at a predetermined level,

c) filtering the flux of said secondary electrons and said low-energy electrons reflected from the surface of said substrate in order to select most or all of said reflected low-energy electrons, or a portion of said reflected low-energy electrons, and to reject most or all of said secondary electrons,

d) focusing said reflected low-energy electrons create an image of said substrate in a plane of a detector, and

e) detecting said reflected low-energy electrons, thereby imaging a portion of said substrate.

(Emphasis added.)

Like claim 61, claim 66 relates to exposing a substrate both to a) an influx of relatively high-energy electrons to cause secondary electron emission and to b) an influx of relatively low-energy electrons to maintain surface charge. In contrast to claim 61, claim 66 applies c) filtering to select the reflected low-energy electrons while rejecting the secondary electrons, and d) focuses the reflected electrons to create an image in a plane of the detector. In other words, claim 66 isolates detection of reflected low-energy electrons while claim 61 isolates detection of secondary electrons.

Regarding Ose, the acceleration or deceleration capability in the electron gun of Ose relates to varying the energy of a relatively high-energy electron beam; it does not provide an influx of relatively low-energy electrons for surface charge maintenance as recited in limitation b). In addition, Ose does not disclose or suggest c) filtering to select the reflected low-energy electrons while rejecting the secondary electrons. Hence, applicants respectfully submit that the method of claim 66 is patentable over the combination of Reinhorn, Todokoro, and Ose.

Claim 67 depends from claim 66. Furthermore, claim 67 requires the filtering to select the reflected low-energy electrons to be achieved by selection based on angular distribution from the surface of the substrate. In regards to Ose, the angular filter **62** in Ose does not select reflected low-energy electrons, rather the angular filter **62** selects secondary electrons.

Claim 68 is hereby amended for purposes of clarification only (to correct a typographical error in the claim dependency and to correct the antecedent basis of "specular angle") and has not been amended for purposes of overcoming prior art. Claim 68 as amended now depends from claim 66. Furthermore, claim 68 requires that the filtering selects the reflected low-energy electrons away from a specular angle. In regards to Ose, the angular filter **62** in Ose does not select reflected low-energy electrons, much less the reflected low-energy electrons away from a specular angle.

Independent claim 69 is hereby amended in regards to the antecedent basis of "plane". Claim 69 as amended now recites the following limitations.

a) exposing said substrate to an influx of relatively high-energy electrons, said high-energy electrons having an energy selected to cause secondary electrons to leave said substrate,

b) exposing said substrate to an influx of relatively low-energy electrons, said electrons having both an energy and a current density profile selected to maintain surface charge present on said substrate at a predetermined level,

c) filtering said secondary electrons and the portion of said relatively low-energy electrons which are reflected from the surface of said substrate, in order to select most or all of said secondary electrons which are emitted at angles other than perpendicular to the substrate and most or all of said reflected electrons which are scattered away from the specular angle, and to reject most or all of said secondary electrons which are emitted at an angle perpendicular to the substrate and most or all of said reflected electrons which are scattered at the specular angle,

d) focusing said selected secondary electrons and said selected reflected electrons to create an image of said substrate in a plane of a detector, and

e) detecting said selected secondary electrons and selected reflected electrons, thereby imaging a portion of said substrate.

(Emphasis added.)

Like claims 61 and 66, claim 69 relates to exposing a substrate both to a) an influx of relatively high-energy electrons to cause secondary electron emission and to b) an influx of relatively low-energy electrons to maintain surface charge.

Regarding Ose, the acceleration or deceleration capability in the electron gun of Ose relates to varying the energy of a relatively high-energy electron beam; it does not provide an influx of relatively low-energy electrons for surface charge maintenance as recited in limitation b). Furthermore, Ose does not disclose or suggest c) filtering to select non-perpendicular secondary electrons and reflected electrons away from the specular angle, nor does Ose disclose or suggest d) focusing the selected electrons to create an image of said substrate in the plane of a detector. Hence, applicants respectfully submit that the method of claim 69 is patentable over the combination of Reinhorn, Todokoro, and Ose.

Conclusion

For the above-discussed reasons, applicants believe that claims 9-15, 36-57, 61-62, and 66-69 are patentable over the cited art. Favorable action is respectfully requested. The examiner is also invited to call the below-referenced attorney to discuss this case.

Respectfully Submitted,

Dated: April 7, 2003

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